

Notes on *Arion hortensis* s.l. and *A. fasciatus* s.l. in Denmark

(Gastropoda: Pulmonata)

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MOTS-CLEFS: Pulmonata, *Arion hortensis* s.l., *Arion fasciatus* s.l., spermatophores, Danemark.

ABSTRACT. *Arion hortensis* s.l. and *A. fasciatus* s.l. from Denmark in the collections of the Zoological Museum of Copenhagen, were revised. All the samples labelled as *A. hortensis*, should in fact be referred to as *A. distinctus*. The two genital forms of this species are reported. The type with a tripartite oviduct is new for Denmark. Danish *A. fasciatus* s.l. comprises *A. fasciatus* s.s., *A. circumscriptus* and *A. silvaticus*. Two specimens of the latter species contained fresh spermatophores. This observation is discussed in relation to the breeding biology of *A. fasciatus* s.l.

RESUME. *Arion hortensis* s.l. et *A. fasciatus* s.l. ont été révisés dans les collections du Musée Zoologique de Copenhague. Tous les spécimens étiquetés *A. hortensis* se réfèrent en réalité à *A. distinctus*. Les deux formes génitales de cette espèce sont rapportées. La forme présentant un oviducte tripartite est nouvelle pour le Danemark. *A. fasciatus* s.l. au Danemark est composé de *A. fasciatus* s.s., *A. circumscriptus* et *A. silvaticus*. Deux spécimens de cette dernière espèce contenaient un spermatophore. Cette observation est discutée en relation avec la biologie de reproduction de *A. fasciatus* s.l.

INTRODUCTION.

Recently, much attention has been paid to the systematics of two small arionid slugs viz. *Arion hortensis* Férussac, 1819 s.l. and *A. fasciatus* (Nilsson, 1823) s.l. As a result of this, each of these taxa appeared to be in fact a complex of sibling species.

DAVIES (1977, 1979) studied *A. hortensis* in Great Britain and subsequently splitted this taxon into three distinct species, viz. *A. hortensis* Férussac, 1819 s.s., *A. distinctus* Mabille, 1868 and *A. owenii* Davies, 1979. Later on, DAVIES' work was elaborated and confirmed by DE WILDE (1983), DE WINTER (1984), BACKELJAU (1985a, 1985b, 1987), BACKELJAU & MARQUET (1985), BACKELJAU & VAN BEECK (1986) and DOLAN & FLEMING (1988).

A. fasciatus was originally revised by LOHMANDER (1937) (sub nomen *A. circumscriptus*) who defined three forms: *A. fasciatus* (Nilsson, 1823) s.s., *A. circumscriptus* Johnston, 1828 and *A. silvaticus* LOHMANDER, 1937. Later authors usually have confirmed LOHMANDER's results (e.g. WALDÉN 1955, 1965, 1969; LEHTINEN 1957; LOZEK 1958; HUDEC 1960; CHICHESTER 1967; CHICHESTER & GETZ 1969). Since then it is a current taxonomic practice to consider the three forms as separate species (e.g. KERNEY et al. 1983; WIKTOR 1983; CAMERON et al. 1985; WALDÉN 1985), even though no one so far has been able to present convincing evidence in favour of this interpretation (BACKELJAU et al. 1987). Hence further research on this matter is needed.

The present paper does not claim to solve the latter problem. Yet, it provides some preliminary data on the occurrence of both *A. hortensis* s.l. and *A. fasciatus* s.l. in Denmark. The terrestrial malacofauna of this country is indeed still relatively poorly known and since the basic work of STEENBERG (1911), new data with respect to Danish terrestrial molluscs, have been published only sporadically (e.g. SCHLESCH 1934; JESPERSEN 1945; LOHMANDER 1959; HÖPNER-PETERSEN 1964).

MATERIAL AND METHODS.

The two species complexes in the collections of the Zoological Museum of Copenhagen (ZMC) were studied. Slugs were dissected as outlined by DE WILDE (1983). In this way, 76 specimens of *A. hortensis* s.l. and 78 of *A. fasciatus* s.l. were investigated. A locality list is given in the Appendix.

RESULTS.

A. hortensis s.l.

All the specimens studied belong to *A. distinctus*. Externally they are characterized by a dark lateral mantle band, which runs over the pneumostome. The genitalia reveal in the atrium a conical-shaped penial papilla covering the outlet of the epiphallus, a typical feature of *A. distinctus* (Fig. 1C).

The oviduct of the Danish specimens shows a dimorphism such as reported by DAVIES (1977, 1979) in Great Britain. The majority of the specimens have a bipartite oviduct, consisting of a proximal firm portion and a slender distal channel (Fig. 1A). Seventeen individuals however, have a tripartite oviduct, in which the firm portion is proximally (this is towards the genital atrium) preceded by an eversible one (Fig. 1B). Both these genital forms occur microsympatrically in Denmark (e.g. Giese-gard and Kolding, see Appendix and Fig. 2). It is, as far as we know, the first time that the tripartite form is reported from Denmark. Yet, it has been recorded from W. Germany, Austria, Switzerland, France, the British Isles and The Netherlands (DE WINTER 1984). In Belgium, on the contrary, *A. distinctus* with a tripartite oviduct has, despite intensive searching, hitherto not been found (DE WILDE 1983, 1986; BACKELJAU 1985a, 1985b, 1987; BACKELJAU & MARQUET 1985; BACKELJAU & VAN BEECK 1986).

The sampling localities of Danish *A. distinctus* are indicated in Fig. 2. The actual distribution of the species should, however, be determined on much more material.

A. hortensis s.s. and *A. owenii* were not found among the specimens studied.

A. fasciatus s.l.

All the specimens in the collection were labelled as *A. circumscriptus*. Yet, the three forms as defined by LOHMANDER (1937) were clearly represented. Our identifications were based on the following criteria (material in alcohol):

1) *A. fasciatus* s.s.: A large slug which sometimes resembles *A. subfuscus* (Draparnaud, 1805); back and mantle uniformly coloured, varying from very pale to deeply dark; body sides below the lateral bands very pale; atrium relatively small (in comparison with the other genital parts), with varying ratios between length and breadth; no dark pigmentation on the inner side of the epiphallus; oviduct relatively long and slender, usually at most half as broad as the proximal part of the epiphallus (Fig. 3E-F).

2) *A. circumscriptus*: Small to medium sized slug; back and mantle distinctively mottled with dark spots; body sides below the lateral bands deeply dark grey; atrium relatively large and at least twice as long as broad; inner side of the proximal third of the epiphallus usually with a dark pigmentation; oviduct relatively short and about as broad as the proximal part of the epiphallus (Fig. 3A-B).

3) *A. silvaticus*: Small to medium sized slug; back and mantle more or less uniformly dark; body sides below the lateral mantle bands very pale; atrium relatively large with varying ratios between length and breadth, but usually not so slender as in the foregoing species; no dark pigmentation on the inner side of the epiphallus; oviduct relatively short and about as broad as the proximal part of the epiphallus (Fig. 3C-D).

These features seem to provide a clear-cut separation of the three forms. Yet, they are highly variable and consequently it remains often difficult to identify these slugs. Hence, some of our identifications are uncertain. This does not affect, however, the fact that the three forms are clearly present in Denmark since the collection contains several typical specimens of each.

Two large specimens of *A. silvaticus* (perhaps one of them should actually be referred to as *A. fasciatus* s.s.) contained a fresh spermatophore in their bursa (Table 1). These records are interesting since *A. silvaticus*, like the two other members of the complex, is commonly believed to be a self-fertilizing species (McCRACKEN & SELANDER 1980; FOLTZ et al. 1982, 1984; SELANDER & OCHMAN 1983). Spermatophores, however, are structures which are produced during courtship (RUNHAM & HUNTER 1970; LIND 1973). Hence, their presence may be interpreted as indicating that mating can occur in *A. fasciatus* s.l. However, observations on this subject seem to be very rare. Only GERHARDT (1935) provided some details on the copulation of *A. fasciatus* s.l. Yet, records of spermatophores of *A. fasciatus* s.l. are not exceptional (ÖKLAND 1922; LOHMANDER 1937; LUPU 1974) and as it can be inferred from Table 1, they appear to be produced from April to July, with a peak in May. The copulations ob-

served by GERHARDT (1935), however, took place in January.

The fact that the *A. fasciatus* s.l. species produce spermatophores and display mating behaviour, suggests that these slugs may be capable to cross-fertilize under certain conditions. Yet, electrophoretic surveys hitherto only provided evidence in favour of uniparental reproduction (McCRACKEN & SELANDER 1980; FOLTZ et al. 1982, 1984; SELANDER & OCHMAN 1983; BACKELJAU et al. 1987). Moreover, neither the occurrence of copulations, nor the production of spermatophores actually prove that eggs are also fertilized by allosperm. Yet, as other arionid species such as *A. subfuscus* (Draparnaud, 1805) and *A. ater* (Linnaeus, 1758), seem to have mixed breeding systems (WILLIAMSON, 1959; McCRACKEN & SELANDER 1980; FOLTZ et al. 1982; SELANDER & OCHMAN 1983), we presume that this is also the case with *A. fasciatus* s.l. (BACKELJAU et al. 1987; BACKELJAU & VAN ROMPAEY 1988, BACKELJAU et al. in prep.). In this species, uniparental reproduction would then occur much more frequently than outcrossing. However, whether the uniparental reproduction of *A. fasciatus* s.l. is to be referred to as self-fertilization (autogamy) or to as some kind of parthenogenetic system, remains to be decided (BACKELJAU et al. in prep.).

Because the breeding biology of *A. fasciatus* s.l. is still so poorly known, we would be happy to receive further observations on this subject. Thus records of copulating *A. fasciatus* s.l., if possible accompanied by notes on the locality, the date, the environment, the duration of mating, etc., and photographs or drawings of the courtship of these slugs, would be gratefully welcomed by the authors. Of course, further findings of spermatophores and observations on matings in captivity, would be highly appreciated too. Finally, it would be most interesting if copulating specimens and their offspring could be analysed electrophoretically. Therefore, it may be extremely useful if such individuals, together with other specimens of the same populations, could be sent alive to us.

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APPENDIX 1.

Sample list of the specimens studied in the collection of the ZMC.

A. distinctus

(A: bipartite oviduct; B: tripartite oviduct):

Giesegard, Sjaelland, 23-VIII-1910 (2A + 4B); Giesegard, Sjaelland, X-1910 (9A + 4B); Haldagerlille, Sjaelland, 28-IV-1945 (1A); Hellebaek, Sjaelland, 1920, (15A); Holsteinborg, Sjaelland, no date (5A); Kolding, Jylland, no date (6A + 6B); København, Sjaelland, 01-X-1943 (1A); Snekkersten, Sjaelland, 26-III-1937 (1A); Springforbi, Sjaelland, 13-X-1917 (3B); Thisted, Jylland, V-1911 (18A); Thurø, south of Fyn, no date (1A).

A. fasciatus s.l.

(C: *A. circumscriptus*; F: *A. fasciatus* s.s.; S: *A. silvaticus*):

Aebelö, summer of 1940 (4S); Aen, Arö (Jylland), 27-V-1950 (1S); Arresö, Sjaelland, 26-V-1896 (2F); Björnö, south of Faborg, 30-VII/01-VIII-1939 (1C + 2S); Braendevaenge, Langeland, VII-1943 (1S); Bregninge, Tasinge, VII-1940 (2S); Dyrehaven, Sjaelland, 12-IV-1896 (4F); Dyrehaven, Sjaelland, 02-VIII-1896 (1C); Egholm, 13-VI-1909 (2S); Fanefjord, Möen, VIII-1917 (1F + 1S); Hjortö, south of Fyn, VII-1959 (2C + 2F + 1S); Holstein-

borg, Sjaelland, 28-IV-1945 (1F + 3S); Kjarstrup, Tasinge, 1945 (3C); Klinte, Möen, 14-XII-1946 (1F); Lyö, south of Fyn, VII-1939 (1F + 3S); Mollea, Sjaelland, 11-VII-1911 (1S); Ögavl, Thurö, VII-1939 (3S); Skern, Jylland, 09-VIII-1916 (2S); Stigtehavet, Langeland, VII-1943 (1S); Strandskoven, Aerö, VIII-1943 (1C); Strynø, south of Fyn, VII-1943 (1C); Tystrup, Sjaelland, 04-VII-1942 (2S); Tystrup, Sjaelland, 25-IV / 5-VIII-1945 (1C + 1F + 5S); Thisted, Jylland, V-1911 (20F); Tranekaer, Langeland, VII-1943 (1C).

BELGIUM

KBIN AC 0944-1

A. silvaticus

Bossut-Gottechain, 03-IV-1978

KBIN AC 1952-1

A. circumscriptus

Sougné-Remouchamps, 22-V-1979

KBIN AC 4070-2

A. silvaticus

Vielsalm, 04-V-1985

KBIN AC 4070-4

A. circumscriptus

Vielsalm, 04-V-1985

CZECHOSLOVAKIA

KBIN AC 4066-15

A. fasciatus

Teplice, 22-V-1984

DENMARK

ZMC AC 37-1

A. silvaticus (?)

Holsteinborg, 28-IV-1945

ZMC AC 38-5

A. silvaticus

Tystrup, 04-VII-1942

SWEDEN

SMNH 6667-1

A. silvaticus

Tierps, 23-V-1955

SMNH 6675-2

A. silvaticus

Overgrans, 09-V-1955

SMNH 6675-4

A. silvaticus

Overgrans, 09-V-1955

SMNH 6675-6

A. silvaticus

Overgrans, 09-V-1955

SMNH 7475-1

A. silvaticus

Arnas, 12-VI-1958

SMNH 7475-2

A. silvaticus

Arnas, 12-VI-1958

SMNH 8079-1

A. fasciatus

Dalby Hage, ?-V-1937

TABLE 1.

Records of spermatophores found in *A. fasciatus* s.l. Abbreviations: KBIN = Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel; SMNH = Swedish Museum of Natural History, Stockholm; ZMC = Zoological Museum of Copenhagen.

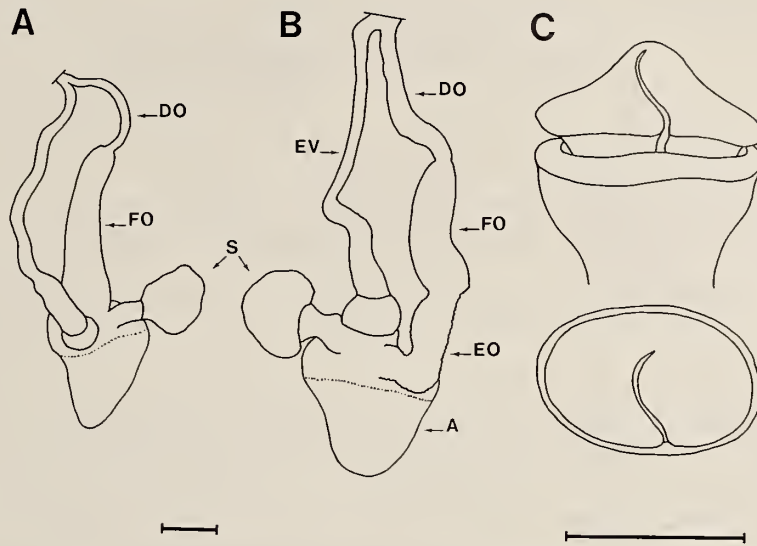


Fig. 1. Camera lucida outlines of the proximal genital parts of Danish *A. distinctus*. Scale lines: 1 mm. A - Form with a bipartite oviduct (Giesegard, Sjaelland). B - Form with a tripartite oviduct (Giesegard, Sjaelland). C - Penial papilla seen from aside and from above (Snekkersten, Sjaelland). Abbreviations used: A = genital atrium; DO = distal channel of the oviduct; EO = eversible portion of the oviduct; EV = epiphallus and vas deferens; FO = firm portion of the oviduct; S = spermatheca.



Fig. 2. Sampling localities of *A. distinctus* in Denmark. Circles: form with a bipartite oviduct. Triangles: form with a tripartite oviduct. Squares: mixed populations of both forms.

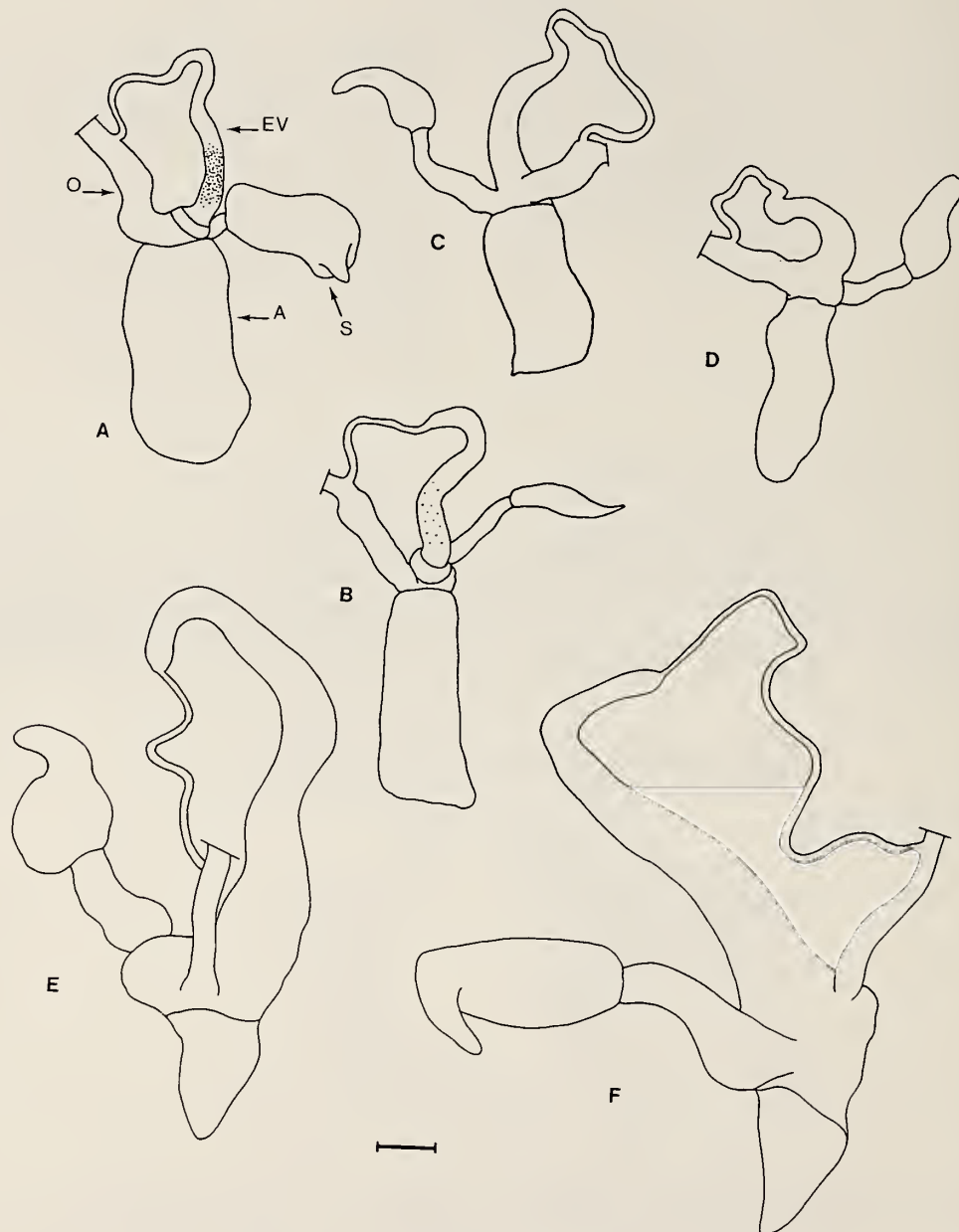


Fig. 3. Camera lucida outlines of the proximal genital parts of Danish *A. fasciatus* s.l. Scale line: 1 mm. A - *A. circumscriptus* (Hjortö). B - Idem (Strynö). C - *A. silvaticus* (Tasinge). D - Idem (Langeland). E & F - *A. fasciatus* s.s. (Thisted, Jylland). Abbreviations used: A = genital atrium; EV = epiphallus and vas deferens; O = oviduct; S = spermatheca.